

Course Code	Course Name	Credits
26PH507	CONDENSED MATTER PHYSICS	04

Course Objectives

- The objective of the paper is to aware the students about the field of Condensed matter physics
- This paper enable the students to understand about the crystal structure, interaction with X-ray, lattice vibrations, defects, electronic properties and the magnetic properties etc.
- It also helps the students to understand various properties about crystals.
- This paper deals with the study of structural properties of solids.

Learning Outcomes

After completion of the course, students will be able to:

- Understand the physics behind structural properties of the solids.
- Tailor the properties of solids with proper understanding.
- Pursue the research work in the field of material science and nanotechnology

Unit 1 - Crystal Structure (11 Hrs.)

Crystalline state – crystalline solids-Fundamental crystal structure – Lattice parameter-Unit cell- Miller indices- fundamental types of lattice, 2d and 3d Bravais lattice and crystal systems. Elements of symmetry operations- points and space groups. Reciprocal lattice and Vectors - Brillouin zones- atomic scattering Factor-Geometrical structure factor.

Unit 2 – Lattice Vibrations and Thermal Properties (12 Hrs.)

Vibration of crystals with monoatomic lattices and diatomic lattices-One dimensional lattice of identical atoms-vibrations modes of diatomic linear lattice – quantization of lattice vibrations –inelastic scattering of neutrons by phonons-Electrical resistivity of metals-Derivations of Boltzmann transport equation.

Unit 3 - Free Electron Theory, Energy Bands and Semiconductor Crystals (12 Hrs.)

Sommerfeld model free electrons- Fermi Energy Dirac distribution – Sommerfeld theory of electrical conductivity- Electrical conductivity and Ohm's law – Energy levels in one dimension- gas three dimension- Origin of the energy band gap –Bloch functions – Kronig –Penny model; Classification of metal, semiconductor and insulator - Semiconductors – Bandgap – Properties of holes - effective mass in semiconductors - Intrinsic carrier concentration.

Unit 4 – Magnetic Properties (12 Hrs.)

Origin of magnetism; Langevin theory of diamagnetism and Paramagnetism-Ferromagnetism- Antiferromagnetism and Ferrimagnetism- Quantum theory of paramagnetism- Curie law-Quenching of orbital angular momentum- Cooling by adiabatic demagnetization paramagnetism-Weiss theory of ferromagnetism–Nuclear Magnetic Resonance frequency- Coercive force and hysteresis-loss- basis domain theory.

Unit 5 - Superconductivity (13 Hrs.)

Occurrence of Superconductivity – destruction of superconductivity by magnetic field - Meissner effect; Type I and Type II Superconductors; Heat capacity, energy gap and isotope effect ; London equation –Outline of BCS theory – BCS ground state – Cooper pairs - Flux quantization –Josephson superconductor tunneling – DC and AC Josephson effect- Applications of superconductors.

Reference Books:

1. The Kondo Problem to Heavy Fermions.-A. C. Hewson
2. Fermi-Liquid” Description of the Kondo Problem-P. Nozières
3. Solution of the Kondo Problem- N. Andrei, K. Furuya, and J. H. Lowenstein
4. Perspectives in Quantum Hall Effects- S. Das Sarma, A. Pinczuk (eds.)

Websites and eLearning Sources:

1. https://onlinecourses.nptel.ac.in/noc22_ph09/preview
2. https://youtu.be/TfJtwOcyx_0?si=wAFz3gnP7I3FSokQ
3. <https://youtu.be/s7pRazsBj48?si=VmaVRgeUIW0PulFW>

COs and Bloom's Taxonomy Mapping – 26PH507

Course Outcomes	On successful completion of this course, students will be able to	BTL
CO1	Identify and recall the fundamental concepts of crystal structures, including lattice parameters, Miller indices, and types of lattices.	K1
CO2	Explain the principles of lattice vibrations and thermal properties, including the Boltzmann transport equation and its implications for electrical resistivity.	K2
CO3	Apply the free electron theory and band theory to analyze the electrical properties of metals and semiconductors, including calculations of Fermi energy and carrier concentration.	K3
CO4	Analyze the magnetic properties of materials, including the effects of temperature and external fields on magnetism and the differences between various magnetic materials.	K4
CO5	Evaluate the implications of superconductivity phenomena and create theoretical models to explain the Meissner effect and BCS theory applications in practical superconducting devices.	K5, K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH507

Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)						Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.58
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	1	1	2	3	3	2	2	2	2.25
CO4	3	3	3	3	2	1	2	3	3	3	2	2	2.42
CO5	3	3	3	3	2	2	3	3	3	3	3	2	2.75
Total													2.20

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

